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2011 Symposium on Human Body Dynamics

Foreword

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Abstract

The IUTAM Symposium on Human Body Dynamics: From Multibody Systems to Biomechanics was held June 5-8, 2011, at the University of Waterloo, Canada. Consistent with the goal of IUTAM Symposia, a small group of 27 international experts gathered to discuss the state-of-the-art in the multibody dynamic analysis of human motions, with applications ranging from gait and balance to the prediction of motions and stresses resulting from surgery. In these Procedia IUTAM, the contributions of these 27 experts to biomechanics modelling, computer simulation, and experimental validation are documented.

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Keywords: human body dynamics; modelling; simulation; biomechanics; multibody dynamics.

1. Scope of Symposium

Biomechanics is a very challenging interdisciplinary research topic for the scientific community of multibody dynamics. The goal of this IUTAM Symposium was to bring together an interdisciplinary group of international experts in dynamic modelling, human experimentation, and biomechanics applications. Theoretical and applied mechanics has contributed to the motion research of healthy and disabled human beings through sophisticated modelling and analysis methods. Recently, multibody system dynamics has been successfully applied to studies on human walking and hearing [1].

However, the modelling process has to take into account the dynamical properties of muscles, ligaments, tissues and skin which are not readily available in the engineering community. The design and verification of reliable models for the complex motion of, and within, the human being requires an interdisciplinary cooperation that is facilitated and enhanced by this Symposium.

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These Procedia IUTAM will help medical and biomechanics practitioners to improve their techniques since the validated models provide greater insight than experiments alone; use of the models also reduces the number of human experiments required by solely experimental research. On the other hand, multibody dynamicists will get valuable suggestions for new and innovative research activities and modelling techniques.

2. Research Topics

The 2011 IUTAM Symposium on Human Body Dynamics was a resounding success, with 27 international experts presenting their latest research on modelling methodologies, experimental methods for validation and parameter identification, and biomechanics applications.

Methodologies ranged from fundamental approaches based on multibody dynamics or finite element analysis, or an integrated combination of the two. Advanced kinematics was used to study open-loop and closed-loop topologies, and optimal control theory was adapted to biomechanics applications. Specialized models were developed for muscles, tendons, and ligaments, as well as contacts occurring between soft human tissues.

To support new methodologies in parameter identification, a number of experimental techniques were used, including molecular and magnetic resonance imaging (MRI), electromyography (EMG), and ultrasound. Motion capture systems were used to track subject kinematics, while force plates and transducers were used to measure contact forces in joints, and between a subject and their environment. Where appropriate, cadavers were used to gather the necessary experimental data.

Biomechanics applications were far-ranging and far-reaching, and included gait analysis, human balance and fatigue, and stress analysis in bones and joints. Upper arm motions were modelled to study rotator cuff injury, and detailed multibody models were used to design knee and hip replacements as well as ankle orthoses. Predictive dynamic simulations were used to investigate spinal cord injuries and the outcomes of orthopedic surgeries. Results from bipedal robotics were used to study human motion control, and multibody biomolecular simulations were presented. Multibody dynamic analyses were used to design rehabilitation devices and techniques for injured subjects, and to develop strength training and strategies for high-performance athletes.

3. Speakers and Organizing Committee

The 8 members of the Symposium organizing committee are listed in Table 1. These individuals, combined with the 27 speakers participating in the Symposium, represent 11 different countries around the globe — making this Symposium a truly international event. The small number of invited speakers is consistent with that recommended by IUTAM for a 3-day Symposium such as this [2], which is designed to promote in-depth, intimate discussions and new research collaborations.

The IUTAM Symposium on Human Body Dynamics was held June 5-8 at the University of Waterloo in Canada; full details of the venue, talks, and events are available on the Symposium website: http://iutam2011.uwaterloo.ca.

Table 1. Symposium organizing committee

Committee member	Institution	Location
Jorge Ambrósio	Instituto Superior Tecnico	Lisbon, Portugal
Felix Chernousko	Russian Academy of Sciences	Moscow, Russia
Javier Cuadrado	University of La Coruña	Ferrol, Spain
Scott Delp	Stanford University	Palo Alto, USA
Andrés Kecskeméthy	Duisburg-Essen University	Duisburg, Germany
József Kövecses, Co-Chair	McGill University	Montreal, Canada
John McPhee, Chair	University of Waterloo	Waterloo, Canada
Atsuo Takanishi	Waseda University	Tokyo, Japan

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References

[1] Schiehlen, W, Recent trends in multibody system dynamics. *Multibody Sys Dyn* 2007; **18**:3–13.

[2] http://www.iutam.net/